Virtual Problem Solving for Homeland Security

During a simulated terrorist attack on a water treatment facility in Opelika, Alabama, the mayor (woman on cellular phone) and other emergency managers train to prepare for an optimal response.

TERRORIST attack on the water treatment plant! The mayor and other emergency responders evacuate schools, respond to medical emergencies, and pursue the perpetrators. Fortunately for the town of Opelika, Alabama, the attack was purely hypothetical.

The town mayor, fire and police personnel, medical staff, school administrators, and other emergency managers used the Livermore-developed Joint Conflict and Tactical Simulation (JCATS) model to train for responding to an attack on the civilian infrastructure. JCATS is a Department of Defense tool for simulating joint military exercises and is routinely used in major military exercises worldwide. (See *S&TR*, January/February 2000, pp. 4–11.)

The Opelika simulation entailed an intentional chlorine gas release. Following the attack, portions of the city were evacuated, schools were locked down, and a SWAT team responded to the terrorists. Triage facilities were quickly established, and hospitals and medical clinics swung into high gear to accept people overcome by the poisonous gas. Opelika's emergency managers ran numerous scenarios, each more complex than the last. Finally, a single field exercise that included the local populace gave emergency managers the opportunity to put what they had learned into practice. JCATS enabled the managers to develop emergency responses and train responders for potential events in a cost- and time-effective manner. Conducting a comparable series of real-life field exercises would have been prohibitively expensive.

JCATS' use at Opelika was its first application in a civilian setting. The successful exercise prompted Livermore to modify JCATS specifically for civilian uses. The new tool, known as Advanced Combat and Tactical Simulation (ACATS), is designed for federal, state, and local agencies to prepare for possible acts of terrorism.

Led by computer scientist Mike Mercer, the ACATS team has incorporated JCATS' capabilities for training, rehearsing missions, exploring tactical possibilities, and assessing vulnerabilities into scenarios in a civilian setting. Hypothetical situations range from the spread of a chemical or biological agent within a building or in the streets to planning evacuations from buildings. ACATS replaces the soldiers, guns, tanks, and missiles of JCATS with firefighters, hazardous materials experts, ambulances, and other accoutrements of civilian emergency response.

ACATS is a tool for analyzing tactical vulnerabilities and determining tactical responses to mitigate the effects of a chemical, biological, radiological, or other terrorist attack. It helps train local and state personnel to work together in response to such attacks. ACATS can also be used to analyze a variety of other homeland security issues. "For example, the U.S. Border Patrol has used a version of ACATS to model enhanced tactical and technical capabilities to protect our nation's borders," says engineer Rob Hills.

From JCATS to ACATS

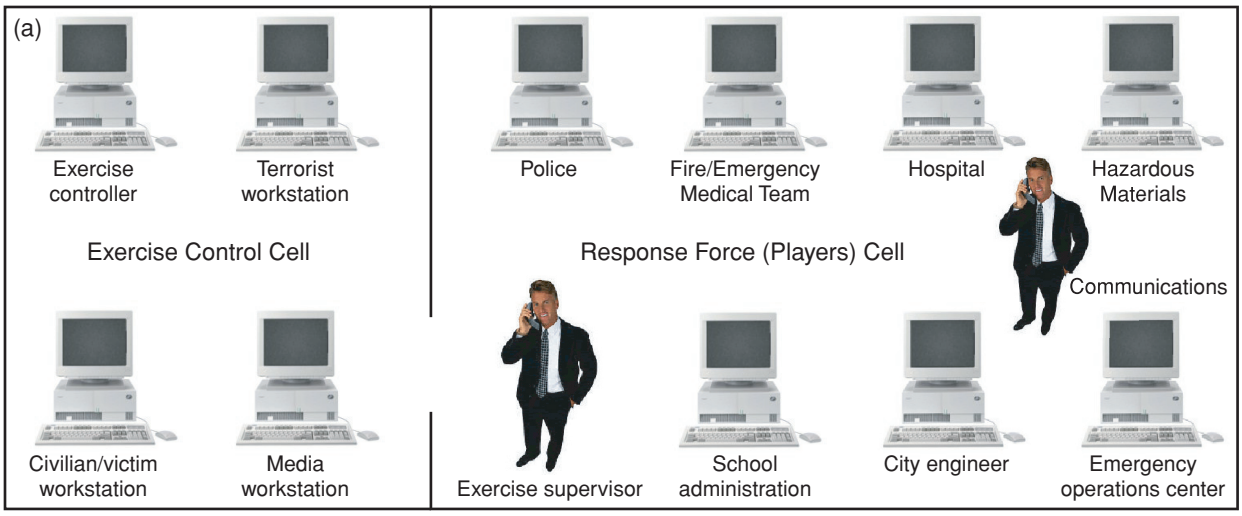
Livermore's 30 years of experience in developing conflict simulation programs led to ACATS' predecessor, JCATS. Less sophisticated conflict simulation programs often represent only aggregate groups of soldiers and vehicles and cannot simulate the interactions between individual soldiers, vehicles, and weapons systems. Such systems use probability tables to determine the outcome of engagements between large forces. In contrast, entity-based simulations like JCATS model the dynamics of individual soldiers, vehicles, and weapons. Entity-based simulations increase the realism of the simulation and allow the "players" to participate more directly.

JCATS gives each soldier, truck, tank, or helicopter its own icon. During a simulation, a single object can be detected, targeted, and destroyed. The largest JCATS exercise to date incorporated more than 40,000 entities.

Players in a JCATS "game" control only the specific entities for which they are responsible and can see and react only to objects within their entities' lines of sight. Meanwhile, the effects of their actions are shown to all players within view on their side. Players can zoom from a theater of operation to a specific room in a building with an accuracy of 10 centimeters.

Entity interactions are based on physics effects models and field data. In a commercial video game, a soldier can jump off a 5-meter cliff and run away unscathed. In a JCATS simulation, on the other hand, the soldier's expected injuries are realistically portrayed.

JCATS was integral to security planning and operational support for the 2002 Winter Olympic Games in Salt Lake City, Utah.



(a) An example of how computer stations would be arranged when a community is developing planned responses to catastrophic events. Each set of emergency responders controls their own personnel and equipment. (b, c) In the simulated attack of the Opelika, Alabama, water treatment plant, the city police and the city manager's staff work interactively as the scenario unfolds.

Simulated games incorporated more than 12,000 entities, modeling Olympics staff and athletes, vehicles, civilian personnel, and equipment. The simulation depicted athletic venues, roads, and other critical areas and mirrored the actual task organization for the Olympics.

JCATS' features are being incorporated into ACATS along with several additions. Mercer's team is using a model developed by the National Institute of Standards and Technology to simulate the dispersion of a chemical or biological agent inside a building. For dispersing an agent outdoors, ACATS links to a validated military model known as VLSTRACK. In the future, ACATS could incorporate higher-resolution dispersion models developed by Livermore's National Atmospheric Release Advisory Center.

Response to a chemical, biological, or radiological attack on a civilian target differs significantly from a military operation. A fundamental difference is the tactical response to the attack, which focuses on minimizing casualties—rather than defeating an enemy—through emergency response coordination, evacuation, and crowd control. This year, ACATS team members began adding features to facilitate modeling of the tactical responses and the movement of large groups of people.

Large groups can be moved more effectively in an ACATS game when crowd behavior is automated, making evacuations from large facilities, such as a military building or sports stadium, easier to model. However, almost every evacuation or large movement of people includes individuals who don't behave as expected. Plans are for ACATS to incorporate the "hero" who doesn't follow orders or the person who behaves irrationally in the face of danger. A goal for ACATS is to include not only the full range of appropriate physics effects but also as many typical human behaviors as possible.

The ACATS team is also working to develop a three-dimensional view of the ACATS field of play. Firefighters and other ground responders playing an ACATS game will get a head-on view of the action, in keeping with how they operate in real life. At the same time, the incident commander will have an overall top-down view.

Effective tools for planning homeland defense are essential to national security. JCATS, which was initially a tool for the Department of Defense, is already proving its mettle for the Department of Homeland Security. Once the transformation from JCATS to ACATS is complete, ACATS will be a major asset for the country.

—Katie Walter

Key Words: Advanced Combat and Tactical Simulation (ACATS), Department of Homeland Security, entity-based simulations, Joint Conflict and Tactical Simulation (JCATS).

For further information contact Rob Hills (925) 423-7344 (hills1@llnl.gov).